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Development of Guidelines for Sewage Sludge Utilization on Agricultural Lands commenced in 1970. Since then, many agencies and organizations have contributed to these Guidelines. The three sponsoring Ontario Ministries, Agriculture and Food, Environment and Health, wish to acknowledge the advice and assistance provided by:

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The Ontario Federation of Agriculture
The Ontario Soil and Crop Improvement Association
The Ontario Municipal Engineers Association
The Ontario Municipal Liaison Committee
Environment Canada
Agriculture Canada

Guidelines for Sewage Sludge Utilization on Agricultural Lands

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Prepared By

Ontario Ministry of Agriculture and Food

Ontario Ministry of the Environment

Ontario Ministry of Health

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Revised January, 1986.

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Ministry of Agriculture and Food

The Honourable
Jack Riddell
Minister
Clay Switzer
Deputy Minister

Ministry of the Environment

The Honourable
Jim Bradley
Minister
Rod M. McLeod
Deputy Minister

Ministry of Health

The Honourable
Murray J. Elston
Minister
Allan E. Dyer MD
Deputy Minister

FOREWORD

These Guidelines are supported by extensive research, which has been ongoing since 1971. This research continues to address concerns such as the potential impacts of sludge spreading practices on human and animal health, land productivity and the environment.

The limits for the concentrations of 11 heavy metals in sludges applied to soil, originally established in the 1978 edition, remain unchanged. Through these limits, metal application to agricultural soils is controlled. The application rates for ammonium plus nitrate nitrogen provide a measure of the plant-available nitrogen in the year of sludge application. These two features ensure that agriculture can benefit from sewage sludge utilization.

The Guidelines were approved for implementation by the Ontario Cabinet in July, 1979. Between 1979 and 1982, a phase-in period enabled municipalities with sludges not meeting criteria to improve those sludges or to develop acceptable disposal alternatives.

The changes in this edition reflect experiences gained since Guidelines implementation was approved. Major new inclusions are criteria for the acceptability of aerobic, dewatered and dried sludges. The rights and responsibilities of those involved in sludge utilization activities -- sewage treatment plant operators, sludge haulers and farmers -- are now more fully defined. Some significant inclusions are revisions to separation distances, waiting periods and sludge blending criteria and a statement of the need for contingency planning by sewage treatment plant operators.

The Sludge Utilization Committee, which includes representation from the Ministries of Agriculture and Food, Environment, and Health, as well as from the University of Guelph, the Municipal Engineers Association, the Association of Medical Officers of Health and the Ontario Federation of Agriculture, oversees interpretation, implementation and review of the Guidelines.

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products. In co-operation with the Ministry of the Environment, it also routinely determines certain metal concentrations in soils, to verify acceptability. The areas sampled include those in which naturally-occurring metal concentrations may be expected to be high and fields to which municipal sewage sludge has been applied for extended periods.

In addition, before the Ministry of the Environment issues Certificates of Approval for sludge application, it verifies that the results of soils analyses, conducted within the previous three years, demonstrate that soil pH and soil phosphorus concentrations are acceptable.

1.3 Value of Sewage Sludge

Sewage sludge is a valuable replacement for nitrogen and phosphorus fertilizers. It also supplies other nutrients, such as magnesium, zinc, copper and boron. The organic matter in sewage sludge improves soil structure.

2.0 CRITERIA RELATING TO SEWAGE SLUDGE PROCESSING

All sewage sludges must be stabilized, before being spread on land, to reduce their odour potential and to reduce the number of pathogenic organisms.

Proper anaerobic and aerobic digestion processes provide appropriate stabilization. Other stabilization methods are discussed in the Ministry of the Environment's "Guidelines to Govern the Stabilization and/or Dewatering of Municipal Sewage Sludge Prior to Its Utilization/ Disposal". Case-by-case judgment on the acceptability of these other methods is usually necessary.

3.0 CRITERIA RELATING TO NITROGEN AND PHOSPHORUS

Before sludge is applied, the farmer should be advised of ammonium plus nitrate nitrogen and phosphorous concentrations, so that sludge and fertilizer rates may be adjusted.

3.1 Available Nitrogen

Nitrogen is usually the most valuable agricultural constituent of fluid anaerobically digested sewage sludges. These sludges normally contain 0.1 to 0.3% total nitrogen, of which 25% to 50% is in the ammonium form. Aerobic and dewatered sewage sludges usually contain appreciably less total nitrogen, a small portion being in the ammonium and/or nitrate form. The ammonium plus nitrate nitrogen present in sewage sludge provides an approximate measure of the nitrogen available for crop use during the year of application. Unless the sludge is immediately incorporated into the soil, up to 50% of its ammonium nitrogen can be lost by volatilization. Conversion by soil microorganisms, of some of the organic nitrogen in the sludge to ammonium and nitrate, partially compensates for this volatilization loss.

3.2 Nitrogen Application Rates

3.2.1 Types of Crop

a. Application rates for sewage sludge are based on the nitrogen fertilizer recommendation for the crop, as described in the OMAF Publications 296 (Field Crop Recommendations) and 360 (Fruit Production Recommendations), which are revised annually.

b. Although many crops benefit from annual nitrogen application, the sludge application rate should not exceed 135 kg. of ammonium plus nitrate nitrogen per hectare, over a five year period or over a four year period for commercial sod.

The intent of this requirement is to control the rate of accumulation of phosphorus and metals in the soil and to provide for their wider distribution.

c. Criteria for the use of sludge for specific crops are given in Table 1. Corn, for grain or silage, grass for hay or pasture, and commercial sod, which require

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GUIDELINES FOR SEWAGE SLUDGE UTILIZATION ON AGRICULTURAL LANDS

1.0 INTRODUCTION

1.1 Purpose, Objective and Scope

a. Purpose

The purpose of these Guidelines is to facilitate the recycling and use of sewage sludge on land, while protecting the quality of food, the health of consumers and the quality of the environment. The Guidelines supplement Ontario Regulation 309, made under the Environmental Protection Act.

b. Objective

The objective of these Guidelines is to ensure that, when sewage sludge is applied to land, the nitrogen, phosphorus, organic matter and micronutrients will benefit crops without degrading the environment or risking the health and productivity of the crops, animals and people of Ontario.

c. Scope

These Guidelines refer to municipal sewage sludge, as included under "processed organic waste" in Ontario Regulation 309, which was made under the Environmental Protection Act. They do not refer to "hauled sewage" (i.e., wastes removed from cesspools, septic tank systems, privy vaults, privy pits, chemical toilets, portable toilets and sewage holding tanks) to other unstabilized wastes, or to other organic wastes.

1.2 Sludge, Soil and Crop Monitoring

The Ministry of the Environment monitors nitrogen, phosphorus, total solids and eleven heavy metals in sewage sludge. The Ministry of Agriculture and Food records the background concentrations of metals in soils, crops, animal feed and animal

substantial amounts of nitrogen, are best suited to use sewage sludge as a nitrogen source. If care is taken in the rate and time of application, sewage sludge can be applied to cereals, which require less nitrogen, and to other crops, including legumes such as alfalfa, trefoil and soybeans, which require little or no nitrogen. The quantity applied, in any one growing season, should be based on:

i. ammonium plus nitrate nitrogen content and

ii. the nitrogen fertilizer recommendation for the crop (see OMAF Publications 296 and 360). Legumes are an exception in that the allowable sludge application rates may provide more nitrogen than is recommended , without crop damage or impairment of groundwater quality. In no case may the nitrogen application rate exceed that specified in Section 3.2.1b. above.

3.2.2 **Time of Application**

Sewage sludge is most effective as a nitrogen source when applied in spring. Late summer and fall applications are permitted, but subsequent nitrogen losses by leaching and denitrification will usually be greater than when the sludge is spring applied. Nitrogen, applied in late summer and fall, is about 50% as available to crops as that in spring applications. The rates of sludge applications in late summer and fall can be increased proportionally. Exceptions are grass and commercial sod, which can use appreciable amounts of nitrogen in the fall.

In no case may the nitrogen application exceed that specified in Section 3.2.1b. Criteria for specific crops are shown in Table 1.

3.3 Nitrogen Analyses

Analyses, to determine the ammonium plus nitrate nitrogen concentrations in sludge must be performed regularly. The frequency of these analyses should permit the estimation of this nitrogen concentration within 25% of the actual concentration.

3.4 Phosphorus

The acid soluble phosphorus content of the sludge should be determined. This phosphorus is approximately 40% as available to plants as fertilizer phosphorus. Sewage sludge is a rich source of plant-available phosphorus.

4.0 CRITERIA RELATING TO CONTAMINANTS

4.1 Metals in Sludge of Concern to Agriculture

The metals in sewage sludges of concern to agriculture are arsenic, cadmium, cobalt, chromium, copper, mercury, molybdenum, nickel, lead, selenium and zinc. Data and criteria for these metals are shown in Tables 2 and 3. In addition, a synopsis of background information is presented in Appendix II.

4.1.1 Acceptability Criteria and Spreading Rates

Only sludges with low metal concentrations are suitable for use on land. Analyses must be provided to show that the sludges used conform with the criteria set out below.

a. Anaerobically Digested Sludges

The nitrogen to metal ratios, as shown in Table 2 column 5, relate ammonium plus nitrate nitrogen concentrations to acceptable metal concentrations. The averages of metal concentrations in the sludge during the preceding 12 months are divided by the average of ammonium plus nitrate nitrogen concentrations during the same period. Alternatively, at the discretion of local MOE staff, the average of the last 3 metals

analyses may be divided by the average of ammonium plus nitrate nitrogen concentrations during the same period. Sludges, with ratios equal to or greater than those in column 5, are suitable for use on land; those with lower ratios are judged unsuitable.

Application rates are based on the concentrations of plant-available nitrogen i.e. ammonium plus nitrate nitrogen. The nitrogen application rate should not exceed that specified in Sections 3.2.1b and c.

b. Aerobically Digested and Other Stabilized Aerobic Sludges

Ontario studies have shown that these sludges have low ammonium plus nitrate nitrogen concentrations and do not normally meet the nitrogen to metal ratios required for anaerobic sludges (Table 2, column 5). However, they contain substantial amounts of phosphorus, micronutrients and organic matter, which are valuable to agriculture.

For the use of aerobic sludges on land to be acceptable, their metal concentrations should not exceed those specified in Table 3. The averages of metal concentrations in the sludge during the preceding 12 months are divided by the average total solids concentrations during the same period. Alternatively, at the discretion of local MOE staff, the average of the last 3 metals analyses may be divided by the average of total solids concentrations during the same period may be used. Sludges, with concentrations equal to or less than those in Table 3 are suitable for use on land; those with higher ratios are judged unsuitable. Refer to the calculation at the bottom of Table 3.

Aerobic sludges may be applied at rates up to 8 tonnes of solids per hectare per five years. The nitrogen application rate should not exceed that specified in Section 3.2.1b and c.

c. Dewatered and Dried Sludges

These sludges contain substantial amounts of phosphorus, organic nitrogen, micronutrients and organic matter, which are valuable to agriculture. However, there are substantial losses of plant-available nitrogen when sewage sludges are dewatered or dried. For this reason, fluid sludge is preferable to dewatered or dried sludge for use on land.

All dried and dewatered sludge used on land must conform with Table 3. Anaerobically digested sludges used on land must, prior to dewatering or drying, also be stabilized and conform with the criteria set out in Table 2.

Dewatered and dried sludges may be applied at rates up to 8 tonnes of solids per hectare per 5 years. Refer to the calculation at the bottom of Table 3. The nitrogen application rate should not exceed that specified in Sections 3.2.1b and c.

The farmer must be advised of ammonium plus nitrate nitrogen and phosphorus concentrations in dried or dewatered sludge, so that he can adjust sludge and fertilizer applications accordingly.

d. Composted Sludges

Guidelines for composting sewage sludge are being developed. In the meantime, enquiries should be directed to MOE Regional or District Offices.

4.1.2 **Marginally Acceptable Sludges**

A marginally acceptable sludge is one which fails to meet the acceptability criteria for metals, but which is within 10% of those criteria. Such sludges can be applied on a temporary basis. Application rates must then be proportionally reduced. If, after repeated sampling, those sludges do not meet the metals criteria, action must be taken to make them acceptable. Alternatively they must be disposed of by means other than utilization.

4.2 **A Program to Limit Metal Accumulation in Soils**

Only anaerobically digested sewage sludges with ammonium plus nitrate nitrogen to metal ratios equal to or greater than those in Table 2, column 5, or aerobic sludges with metal concentrations no greater than those in Table 3 may continue to be used on land.

The application of a sewage sludge complying with these Guidelines could elevate the metal concentrations of a typical Ontario soil to the maximum limits recommended within 25 to 55 years. If metal concentrations in sludges are further reduced, sludge application can continue for a longer period of time. For example, if the nitrogen to metal ratios for an anaerobic sludge are no greater than those in Table 2 Column 7, its application to the same area of land can continue for at least 250 years.

4.3 **Industrial Organic Contaminants**

There are significant gaps in knowledge, with respect to the fate of organic contaminants in sewage sludges applied to land. There is no evidence at present that organic contaminants in municipal sewage sludge applied to land pose a risk to human health.

Research programs are being undertaken in Canada and the United States to improve methods for determining the nature, extent, fate and effects of toxic organic compounds in the environment.

5.0 CRITERIA RELATING TO SPREADING SITES

Under the Environmental Protection Act, all sludge spreading sites must be certified by the Ministry of the Environment. Prior to site certification and sludge use, factors such as site location, land and soil characteristics and proposed site management methods must be assessed to minimize potential hazards to surface watercourses, groundwater, wells and residences.

5.1 Separation Distances

5.1.1 Surface Watercourses

For the purposes of these Guidelines, a surface watercourse is defined as a natural or established surface watercourse or an open municipal drain along which water flows on a regular basis. Points of direct access (such as catch-basins to drainage tiles or municipal drains) should be treated as watercourses for separation distance purposes.

The minimum distance between the spreading site and a surface watercourse should normally be determined from Table 4, which takes into account land slope and soil permeability. If sludge is incorporated into the soil at the time of application, it may be applied closer to a watercourse than indicated in the Table. However, it should not be applied within 10 metres of any watercourse or body of water.

Ministry of the Environment staff will advise on separation distances from bodies of water or drainage channels other than surface watercourses as defined above.

5.1.2 Groundwater

The ground water table should not be less than 0.9 metres below the soil surface at the time of sewage sludge application.

5.1.3 **Bedrock**

Sewage sludge application should not normally be allowed where the unconsolidated materials overlying bedrock are less than 1.5 metres thick. Under special circumstances, and based on site-specific information which demonstrates that the risk of ground and surface water contamination is minimal, sites with lesser thickness of the unconsolidated materials may be used.

5.1.4 **Residences**

According to Ontario Regulation 309, the minimum separation distances from residences in residential areas and individual residences not in residential areas shall be 1500 feet (450 metres) and 300 feet (90 metres) respectively. If the Regulation should, in the future, permit it and where there is little cause for concern, these distances may be reduced. In no case should they be less than 50 metres and 25 metres respectively.

When sludge is applied to land in the proximity of residences, concerns may arise due to the potential for odours, air-borne drift of sludge particles and surface run-off. The extent of these concerns will depend upon the sludge application method and land slope.

When sludge is spray irrigated, these concerns may be greater than when surface spreading is used. Reduced separation distances may, in future, be permissible when soil injection methods are used.

5.1.5 **Water Wells**

According to Ontario Regulation 309, the minimum separation distance from any water well shall be 300 feet (90 metres). If the Regulation should, in the

future, permit it and where there is little cause for concern, this distance may be reduced. In no case should it be less than 15 metres.

5.2 Soil Criteria

5.2.1 Organic Soils

Sewage sludge may be applied to 'mineral' soils but not to 'organic' soils. 'Organic' soils are soils which contain 17% or more of organic carbon by weight and which have a depth of 0.4 metres or more of unconsolidated organic material. Soils which do not meet these specifications are termed 'mineral'.

5.2.2 Metals

Sewage sludge may not be applied to soils whose metal concentrations are equal to or greater than those in Table 2, column 3.

5.2.3 Phosphorus

Sludges may not be applied to soils containing more than 60 milligrams of sodium bicarbonate extractable phosphorus per litre in the top 15 centimetres.

5.2.4 Soil pH

Most metals are more soluble and available to plants in acid soils than in neutral or calcareous soils. Thus, sewage sludge should be applied only to soils with pH values of 6.0 or greater. However, sludges derived from the lime treatment of sewage for phosphorus removal and lime stabilised sludges may be applied to soils of lower pH, when they will raise the soil pH to 6.0. Soil pH may also be raised by the addition of agricultural lime.

5.2.5 Soils Tests

Certificates of Approval will not be issued, nor will sludge spreading be permitted, unless satisfactory

analyses for phosphorus and soil pH are available from soil samples taken within the previous three years.

5.2.6 **Snow Covered and Frozen Ground**

To minimize runoff, it is preferable that sludge should not be spread on frozen or ice covered soil. Sludge spreading is acceptable when there is little or no frost in the soil and the surface is snow-covered. For flat fields having a sustained slope of not more than 3%, spreading may be allowed on frozen soil, provided that the risks of runoff have been determined to be minimal. In such cases, separation distances from surface water courses should be at least 120 metres. Where surface run-off is expected as a result of snow-melt, a more critical evaluation of the site will be required.

5.3 **Runoff Elimination and Soil Compaction Reduction**

Soil tillage and sewage sludge application should, where possible, follow the contours of the land. Traffic by sewage sludge spreading vehicles should be minimized to reduce soil compaction.

Sewage sludge is best applied to unploughed soil when the residues of the previous crop are present to help control runoff, particularly when sludge is applied during the winter.

5.4 **Waiting Periods After Spreading**

Following sludge application, waiting periods in accordance with Table 1 are necessary. These waiting periods are required because, even after stabilization, sewage sludge contains some pathogenic organisms.

6.0 SLUDGE HANDLING AND SPREADING

6.1 **Sludge Application**

The maximum depth of fluid sludge which may be spread at any one time is 1.3 cm. There may be no subsequent application

until the preceding application has dried. Criteria for maximum application rates are provided in Sections 3.0 and 4.0.

Uniform spreading of sludge is essential to ensure that each part of the field receives the same rates of sludge nutrients and metals. Spreading vehicles should have calibrated equipment which can be relied on to control the rate of sludge application. Unsealed tanks, for which gravity flow and ground speed are the only means of adjusting spreading rates, will not spread sludge uniformly.

Sewage sludge should not be spread if the vehicle would cause undue compaction or damage soil structure. Spreading vehicles with flotation tires are preferred. Even flotation tires can cause serious soil compaction when the soil is wet.

The overall quality of spreading is a major factor affecting the willingness of farmers to continue using sewage sludge.

6.2 Storage and Blending

6.2.1 Requirements for Storage

A Certificate of Approval is required for a sludge storage facility. Sludge spreading may be impracticable during inclement weather and during the required waiting periods between spreading and cropping or pasturing. Sufficient storage must be available to retain sludge during these periods.

In Ontario, earthen lagoons are generally used for sludge storage or blending, but other facilities are also used. Sludge must meet the Guidelines' criteria when it is spread on land. Therefore, it must be well-mixed, so that it is of uniform quality before it is withdrawn from storage.

6.2.2 **Sludge Blending**

Sludge storage presents an opportunity for blending. Two or more sludges with unacceptable nitrogen to metal ratios or metals content may, after blending, form an acceptable sludge mixture. In such circumstances, proper mixing is essential. Periodic verification, that sludge taken from the blending facility is uniform and meets the guidelines' criteria, is required.

6.2.3 **Sludge-Manure Blending**

The blending of acceptable sewage sludge and liquid livestock manure is acceptable, provided adequate storage and land for spreading are available. The spreading rate should be related to the nitrogen requirement of the crop. Not more than 1.3 cm depth of the blended material may be applied at any one time. The total amount of sludge applied per 5 years must not exceed that specified in Section 3.2.1b or Section 4.1.1b. It is the farmer's responsibility to spread blended sludge in accordance with the Guidelines.

6.3 **Responsibilities and Rights**

Some of the responsibilities and rights of those involved in sludge utilization are outlined below.

6.3.1 **Operating Agencies**

The responsibilities of agencies operating sewage treatment plants are set out below.

a. **Record-keeping**

Records are to be kept of:

i. The location of all fields receiving sewage sludge;

ii. The sewage sludge applied to each field; and

iii. Sludge Analyses

A report, similar to that shown in Appendix I, is to be provided to the sludge hauler. The report shall include data on the sludge's average nutrient content per cubic metre.

The farmer shall, on request, be advised of the annual average quantities of metals per cubic metre of sludge.

b. Sample Submission

The number of sewage sludge samples analyzed must be sufficient to establish representative values for all pertinent parameters. Sampling frequency is subject to approval by MOE Regional staff.

c. Monitoring Application Rates

Steps should be taken to verify that the sewage sludge application rates conform with those specified by Certificates of Approval.

d. Contingency Planning

Sewage treatment plant operating authorities are required to prepare contingency plans for situations where sewage sludge quality may temporarily fail to meet the requirements of these Guidelines. These situations may be the result of digester failure or cleanouts and plant maintenance or expansion. These plans must provide for alternative methods for treatment and/or disposal.

Exemption from the Guidelines (see Section 7.0) will be considered only in unusual circumstances.

e. Marginal Sludges

Operating authorities will review the acceptability of their sludges immediately after individual analyses

become available. Measures should be taken to prevent sludges from becoming unacceptable.

Whenever marginal sludges are utilized on agricultural land, the farmer is to be advised of the deviations in sludge quality.

6.3.2 **Sludge Haulers**

The hauler must spread the sludge uniformly over the surface of the land at the rate required by the farmer. (See Section 6.3.3.) The actual nitrogen application rate (in kilograms per hectare) and/or the sludge application rate (in cubic metres per hectare) must not exceed those specified by the Ministry of the Environment.

The hauler must maintain all required separation distances and comply with other site requirements. Staking of distances from wells, watercourse and residences can sometimes facilitate this.

The hauler must ensure that the farmer receives a report, similar to that shown in Appendix I, as soon as practicable after completion of sludge application to any one field.

The rights of the farmer must be respected with regard to timing and rate of application (see Section 6.3.3).

6.3.3 **Farmers**

The farmer, the sludge hauler and the sewage treatment plant operator should work together to develop a sludge utilization program for each field used. The farmer has the right and the responsibility to insist on program flexibility, so that sludge application rates may be

adjusted to suit the nitrogen and phosphorus requirements of the crop. In addition, the farmer may direct that sludge spreading operations be discontinued immediately.

The farmer also has the responsibility to see that appropriate waiting periods between sludge spreading and cropping or pasturing are observed.

Farmers will receive a copy of a report similar to that shown in Appendix I.

7.0 EXEMPTION FROM THE GUIDELINES

When sludge quality deviates from the requirements of these Guidelines, sludge application to agricultural land may be considered, on an interim basis, in unusual circumstances only. These unusual circumstances will not normally include situations which can be foreseen and for which contingency plans, as discussed in Section 6.3.1d, are to be developed.

Exemptions from the Guidelines will be considered on a case-by-case basis, through consultations between staff of the Ministry of the Environment and the Ministry of Agriculture and Food.

8.0 COMPLAINTS AND GUIDELINES INTERPRETATION

Questions on Guidelines' enforcement and their interpretation should be directed to:

a. OMAF local staff, when the questions relate to spreading methods, the need for supplemental fertilizers, crop quality, or animal health.

b. MOE local staff, when the questions relate to site approvals, sludge haulage, sludge quality or environmental issues.

c. The local Medical Officer of Health, when the questions relate to public health.

These agencies consult with one another as may be appropriate to ensure that agricultural, environmental and health considerations are taken into account. When necessary, these agencies also consult with the Sludge Utilization Committee.

TABLE 1: CRITERIA RELATED TO SPECIFIC CROPS

Notes: 1. In any 5 year period (4 years for commercial sod) maximum application rates are:
- For all sludges: 135 kg of ammonium plus nitrate nitrogen per hectare
- For aerobic, dewatered and dried sludges: 8 tonnes of solids per hectare.

2. Not more than 1.3 cm depth or 130 cubic metres per hectare of fluid sewage sludge may be applied at one time.
3. Nitrogen application rates are specified in OMAF publications 296 and 360, which are revised annually.

LAND USE	COMMENTS
Field Corn	Field corn is well-suited for using sludge as a nitrogen source.
Hay, Haylage and Pasture	Fall, winter or spring application of sludge for hay stands containing less than one-third legumes may be followed, after cutting, by normal fertilizer application. Summer sludge applications should be followed by fertilizer applications in the following spring. Waiting periods between spreading sludge and harvesting or grazing are required: • Hay and haylage — 3 weeks • Grazing for horses, beef and dairy cattle — 2 months. • Grazing for swine, sheep and goats — 6 months.
Cereals	Spring application of sludge containing more nitrogen than is recommended for the crop may result in crop lodging. Fall application rates for nitrogen may be proportionally increased, as described in Section 3.2.2.
Commercial Sod	Commercial sod is well-suited for using sludge as a nitrogen source. A waiting period of 12 months, between spreading sludge and harvesting, is required to avoid hazards from parasites.
Perennial Legumes & Soybeans	Hay stands containing more than one-half legumes, and soybeans do not require added nitrogen. However, sewage sludge may be used to supply phosphorus and organic material.
Vegetables	A waiting period of 12 months, between spreading sludge and planting or seeding, is required to avoid hazards from parasites.
Small Fruits	A waiting period of 15 months between spreading sludge and harvesting is required to avoid hazards from parasites.
Tree Fruits and Grapes	Sewage sludge may be applied in late fall (November) or up to 3 months before harvesting. Applications within 3 months of harvesting can result in the late release of nitrogen. This may cause poor fruit quality, delayed hardening of trees and vines and winter injury.
Tobacco	Sludge application is not recommended on land used for tobacco production.
Golf Courses and Recreational Lands	Sludge application is permitted only when processes additional to stabilization have been used to further reduce pathogens. Representatives of the Medical Officer of Health and MOE will assess the suitability of such processes on a case-by-case basis, before approvals are considered.
Home Gardens and Lawns	Sewage sludge should not be made available for use on home lawns and gardens.

TABLE 2

METAL CRITERIA FOR FLUID[a] ANAEROBICALLY DIGESTED SEWAGE SLUDGES

1 Metal	2 Mean Metal Content of Uncontaminated Ontario Soils ug/g)[b]	3 Maximum Permissible Metal Content in Soil (ug/g)[b]	4 Maximum Permissible Metal Addition to Soil kg/ha)[d]	5 Minimum Ammonium plus Nitrate Nitrogen (NH_4^+-N plus NO_3^--N) to metal Ratios Required in Sewage Sludge	6 Number of Years To Reach Maximum Recommended Metal Content in Soil (col. 3), Based on cols. 2, 3 and 5[c,d]	7 Minimum ammonium plus Nitrate Nitrogen (NH_4^+-N plus NO_3^--N) to Metals Ratios Required To Give Maximum Permissible Metal Content in Soil (col. 3) in 250 years[d]
ARSENIC	7	14	14	100	50	480
CADMIUM	0.8	1.6	1.6	500	30	4200
COBALT	5	20	30	50	55	220
CHROMIUM	15	120	210	6	45	32
COPPER	25	100	150	10	55	45
MERCURY	0.1	0.5	0.8	1500	45	8400
MOLYBDENUM	2	4	4	180	25	1700
NICKEL	16	32	32	40	45	210
LEAD	15	60	90	15	50	75
SELENIUM	0.4	1.6	2.4	500	45	2800
ZINC	55	220	330	4	50	20

a Dewatered and dried sludges are to meet the Column 5 criteria prior to dewatering and drying.

b Based on dry weight at 100°C. The terms ug/g and mg/kg are interchangeable.

c Based on 135 kg. of ammonium plus nitrate nitrogen per hectare per five years and sewage sludge having minimum ratios. Number of years is rounded off to the nearest five years.

d Columns 4, 6 and 7 apply to soils of mean metal content (column 2) and require adjustment for soils lower or higher in metal content.

TABLE 3

METAL CRITERIA[a] FOR ALL AEROBIC SEWAGE SLUDGES AND FOR ALL DRIED AND DEWATERED ANAEROBIC SEWAGE SLUDGES

Metal	Maximum Permissible Metal Concentration (mg/kg of solids)[b]
Arsenic	170
Cadmium	34
Cobalt	340
Chromium	2800
Copper	1700
Mercury	11
Molybdenum	94
Nickel	420
Lead	1100
Selenium	34
Zinc	4200

a For permissible number of years to reach maximum metal concentrations in soils, refer to Table 2, column 6.

b Acceptability will be judged on the basis of the ratio of the average metal concentration during the preceding 12 months to the average concentration of solids during the same period or, at the discretion of local MOE staff and when solids and metals analyses are conducted once a month, on the basis of the last 3 results.

CALCULATIONS FOR AEROBIC SLUDGE USE ON LAND

1. To determine sludge acceptability, calculate 'Actual Metal Concentrations' and compare with the above Permissible Values

i.e. $$\frac{\text{Metal Concentration (mg/l)} \times 10^6}{\text{Sludge Solids concentration (mg/l)}} = \frac{\text{mg of metal}}{\text{Kg of solids}}$$

2. Calculate maximum application rate per 5 year period.

i.e. $$\frac{8 \times 10^6}{\text{Sludge Solids (mg/l)}} = \frac{\text{Cubic Metres of Sludge}}{\text{Land Area in Hectares}}$$

TABLE 4

MINIMUM DISTANCES TO WATERCOURSES

Maximum Sustained Slope	Soil Permeability*	Distance (Metres)
0 to 3%	Rapid to Moderately Rapid	60
	Moderate to Slow	120
3 to 6%	Rapid to Moderately Rapid	120
	Moderate to Slow	240
6 to 9%	Rapid to Moderately Rapid	180
	Moderate to Slow	Not permitted
Greater than 9%	All permeabilities	Not permitted

* Soil permeability shall be determined in accordance with the requirements of the Ministry of Agriculture and Food's publication entitled "Drainage Guide for Ontario". The type of soil should be determined with the aid of County Soil Maps, which are available from that Ministry.

NOTES: 1. Spreading should be suspended when run-off is expected.

2. Separation distances should be increased when soils are frozen.

APPENDIX I SEWAGE SLUDGE APPLICATION

PART A - AVERAGE NUTRIENT CONTENT PER CUBIC METRE

To be completed by Sewage Treatment Plant Operator

Sewage Treatment Plant(s) _____

Storage Site _____

Nitrogen (as ammonia plus nitrates) _____ kg/cubic metre

Total Phosphorus _____ kg/cubic metre

Operator's signature _____

PART B - SITE AND SLUDGE SOURCE AND QUANTITY DATA

To be completed by Sludge Hauler

Farm Operator: _____

Date: _____

Site: _____ Field: _____

Area Covered: _____ (Hectares)

Total Sludge Applied: _____ (Cubic Metres)

Application Method: _____

Hauler's signature _____

PART C - COMMENTS

Conversion Factors

1 kg = 2.2 lb;
1 hectare = 2.5 acres;
1 cubic metre = 220 gallons;
1 mg/l = .001 kg/cubic metre

APPENDIX II

METALS OF CONCERN IN ONTARIO SOILS: A SYNOPSIS OF BACKGROUND INFORMATION

Metals in Ontario Sludges

Metals concentrations in Ontario sewage sludges vary widely. Metals such as Cu (copper), Mo (molybdenum) and Zn (zinc) are required by both plants and animals; in addition, Co (cobalt), Cr (chromium) and Se (selenium) are required by animals. All of these elements, along with As (arsenic), Cd (cadmium), Hg (mercury), Ni (nickel) and Pb (lead) can be toxic to plants or animals, or to both, at certain concentrations. The concentrations at which toxicity commences vary from soil to soil and have not been firmly established. Metals such as copper, zinc, selenium and cobalt, should be widely distributed and not concentrated on a few fields or farms. Other metals such as Ag (silver), Au (gold), Be (beryllium), Bi (bismuth), Pt (platinum), Sb (antimony), Sn (tin), Te (tellurium) and Ti (titanium) may also cause toxicities in plants and animals. However, research has indicated that these metals are unlikely to cause problems when sludge is used under Ontario conditions.

When metals have entered the soil they leach very little. Field crops normally remove less than 0.4 kg. per hectare per year of any of the toxic metals from the soil. Thus, to prevent toxic effects, excessive soil metal concentrations must not be allowed to build up. These Guidelines include criteria to guard against metals building up to toxic concentrations in soils.

Acceptable Accumulations of Metals in Soil

Average metal concentrations in Ontario soils have been determined. Metal uptake into growing plants has not been closely correlated with total metal concentrations in soils. Metal uptake depends upon variable factors such

as the crop grown, soil pH, soil organic matter and clay content, soil aeration and the concentrations of nutrients and metals. Consequently, over a period of years, uptake rates do not remain constant.

The total metal concentration in the plough layer seems, at this time, to be the most appropriate criterion for establishing limits for metal additions to soils. The maximum recommended metal concentrations in Ontario soils (see Table 2) are based on the judgment of several people familiar with literature on metals. These recommendations take into account average metal concentrations in Ontario soils and other criteria as follows:

a. Arsenic and Nickel

Recommended maxima were set at twice the Ontario averages because of the known toxic effects on plants.

b. Cadmium

The recommended maximum was set at twice the Ontario average because cadmium's availability to plants is greater than that of other metals and because humans and animals have a low cadmium tolerance.

c. Cobalt, Copper, Selenium and Zinc

Because some Ontario feed crops are deficient in these metals, recommended maxima were set at four times the Ontario averages, to allow for some soil buildup. Copper and zinc are toxic to plants at high concentrations and selenium has a narrow acceptable range in animal feeds.

d. Chromium, Mercury and Lead

These metals are toxic to animals and humans and are not required by plants. Plants take up these metals less readily than other metals. Therefore, the Guidelines permit higher concentrations of these metals

relative to the average content of Ontario soils, than of other metals. Although chromium is not required by plants, it has been found to be essential for animals and it may be deficient in human food.

e. **Molybdenum**

The recommended level of accumulation was set at twice the Ontario average because molybdenum leaches more from well- drained soils than do other metals. On one recorded occasion, molybdenum caused toxicity problems for Ontario livestock.

f. **Aluminum, Boron, Calcium, Iron, Magnesium, Manganese, Potassium, Sodium and Sulphur**

No recommendations have been made, because sludge application is not expected to cause concentrations to become critical under Ontario conditions.

APPENDIX III

REFERENCES

A. RELEVANT LEGISLATION

Copies of legislation may be obtained from the Ministry of Government Services, 880 Bay Street, Toronto, Ontario M5S 1Z8. The Ontario Government Bookstore (first floor - tel: 416-965-2054) handles direct sales. The Publications Centre (fifth Floor - tel: 416-965-6015) handles mail orders.

The Ontario Water Resources Act

This Act provides for the control and protection of quality and quantity of surface and ground waters. It is administered by the Ministry of the Environment.

The Environmental Protection Act

This Act prohibits the contamination of the natural environment and provides for its preservation and improvement. It is administered by the Ministry of the Environment. Ontario Regulation 309, which establishes standards for waste disposal and utilization sites, is issued pursuant to this Act.

The Environmental Assessment Act

This Act provides for the environmental assessment of undertakings carried out by provincial and municipal agencies. It is administered by the Ministry of the Environment.

The Planning Act

This Act provides for orderly planning of the development and use of lands in the province. It is administered by the Ministry of Municipal Affairs and Housing.

B. **OMAF PUBLICATIONS**

Copies of these documents may be obtained from the OMAF offices listed in Appendix IV.

Publication 29: Drainage Guide for Ontario

Publication 296: Field Crop Recommendations (Published Annually)

Publication 360: Fruit Crop Recommendations (Published Annually)

Fact Sheet AGDEX 100/541: How and Where to Use Sewage Sludge in Crop Production

C. **OTHER PUBLICATIONS**

Guidelines to Govern the Stabilization and/or Dewatering of Municipal Sewage Sludge Prior to Its Utilization/ Disposal

These Guidelines may be obtained from the Ministry of the Environment, Water Resources Branch, 1 St. Clair Avenue West, Toronto, Ontario M4V 1K8 (Tel: 416-965-6967)

MOE Fact Sheet: About Sewage Sludge in Agriculture

Obtainable from MOE's Communications Branch in Toronto (Tel: 416-965-7117) and MOE Regional and District Offices.

Agricultural Code of Practice

This is an OMAF, MOE and Ministry of Municipal Affairs and Housing Joint Publication. Information may be obtained from the OMAF and MOE offices listed in Appendices IV and V.

APPENDIX IV

MINISTRY OF AGRICULTURE AND FOOD OFFICES

County/District	Telephone No.	Address
Algoma	705 253-1161	1496 Wellington St. E. Sault Ste. Marie P6A 2R1
Brant	519 759-4190	207 Greenwich St. Brantford N3S 2X7
Bruce	519 881-3301	Box 1330, Walkerton N0G 2V0
Carleton	613 828-9167	26 Thorncliffe Pl. Nepean K2H 6L2
Cochrane N.	705 335-5828	Experimental Farm Kapuskasing P5N 2X9
Cochrane S.	705 273-2509	Box 608, Matheson P0K 1N0
Dufferin	519 941-3830	R.R. 4, Orangeville L9W 2Z1
Dundas	613 774-2313	Box 488, Winchester K0C 2K0
Durham East	416 623-3348	234 King St. E. Bowmanville L1C 1P5
Durham West	416 852-3328	Box 309, Uxbridge L0C 1K0
Elgin	519 631-4700	594 Talbot St. St. Thomas N5P 1C7
Essex	519 776-7361	46 Fox St., Essex N8M 2S2
Frontenac	613 547-3428	Box 651, 1055 Princess St. Kingston K7L 1H3
Glengarry	613 525-1046	Box 579, Alexandria K0C 1A0
Grenville	613 258-3416	Box 2004, Kemptville K0G 1J0
Grey	519 986-2040	181 Toronto St. S. Markdale N0C 1H0
Haldimand	416 772-3381	Box 129, Cayuga N0A 1E0
Halton	416 878-2314	17 Wilson Dr. Milton L9T 3J7
Hastings	613 395-3393	Box 340, Stirling K0K 3E0
Huron	519 482-3428	Box 159, Clinton N0M 1L0
Kenora	807 223-2415	Ontario Government Building Box 3000, Dryden P8N 3B3
Kent	519 354-2150	Box 728, 435 Grand Ave. W. Chatham N7M 5L1
Lambton	519 882-0180	Box 730, Petrolia N0N 1R0
Lanark	613 267-1063	10 Sunset Blvd. Perth K7H 2Y2
Leeds	613 342-2124	Box 635, Brockville K6V 5H8
Lennox & Addington	613 354-3371	41 Dundas St. W. Napanee K7R 1Z5
Manitoulin	705 282-2043	Box 328, Gore Bay P0P 1H0
Middlesex	519 434-6811	367 Ridout St. N. London N6A 2P2
Muskoka & Parry Sound	705 789-5491	Box 130, Huntsville P0A 1K0
Niagara N.	416 562-4142	Vineland Station L0R 2E0
Niagara S.	416 732-7552	574 South Pelham St. Welland L3C 3C8
Nipissing	705 474-3050	222 McIntyre St. W. North Bay P1B 2Y8
Norfolk	519 426-7120	Box 587, Simcoe N3Y 4N5
Northumberland	613 475-1630	Box 820, Brighton K0K 1H0
	416 852-3328	Box 309, Uxbridge L0C 1K0

Continued ...

MINISTRY OF AGRICULTURE AND FOOD OFFICES (Cont'd)

County/District	Telephone No.	Address
Oxford	519 537-6621	Box 666, Woodstock N4S 7Z5
Peel	416 451-5474	3 Elizabeth St. S. Brampton L6Y 1P7
Perth	519 271-0280	413 Hibernia St. Stratford N5A 5W2
Peterborough	705 745-2403	55 George St. N. Peterborough K9J 3G2
Prescott	613 673-5115	Box 110, Plantagenet K0B 1L0
Prince Edward	613 476-3224	Box 470, Picton K0K 2T0
Rainy River	807 482-2310	Front St., Emo P0W 1E0
Renfrew	613 432-4841	315 Raglan St. S. Renfrew K7V 1R6
Russell	613 443-3391	666 Rue Notre Dame, Box 540 Embrun K0A 1W0
Simcoe N.	705 322-2231	Box 340, Elmvale L0L 1P0
Simcoe S.	705 458-9303	Box 370, Alliston L9M 1A0
Stormont	613 933-1581	Box 655, 109-11th St. W. Cornwall K6H 5T3
Sudbury	705 566-1630	1414 LaSalle Blvd. Sudbury P3A 1Z6
Temiskaming	705 647-6701	Box G New Liskeard P0J 1P0
Thunder Bay	807 475-1631	Ontario Government Building 435 James St. S. Thunder Bay P7E 6E3
Victoria	705 324-6125	322 Kent St. W. Lindsay K9V 2Z9
Waterloo	519 884-5390	279 Weber St. N. Waterloo N2J 3H8
Wellington	519 846-5371	Box 159, Fergus N1M 2W7
Wentworth	416 527-2995	R.R. 1, Ancaster L9G 3K9
York	416 895-4519	Newmarket Plaza Newmarket L3Y 2N1

APPENDIX V
MINISTRY OF THE ENVIRONMENT OFFICES

SOUTHWESTERN REGION

London (519 681-3600)
985 Adelaide St. S. N6E 1V3

Windsor (519 254-5129)
250 Windsor Ave. N9A 6V9

Sarnia (519 336-4030)
242A Indian Rd. S. #209 N7T 3W4

Owen Sound (519 371-2901)
1180 20th St. N4K 6H6

Chatham (519 352-5107)
435 Grand Ave. W. N7L 3Z4

WEST CENTRAL REGION

Hamilton (416 521-7640)
119 King St. W. 12th Floor
Box 2112, L8N 3Z9

Cambridge (519 623-2080)
P.O. Box 219, 400 Clyde Rd.
N1R 5W6

Welland (416 735-0431)
637-641 Niagara St. N. L3C 1L9

CENTRAL REGION

Toronto (416 424-3000)
7, Overlea Blvd. 4th Floor
M4H 1A8

Oakville (416 844-5747)
1226 White Oaks Blvd. L6H 2B9

Barrie (705 726-1730)
12 Fairview Rd. L4N 4P3

Gravenhurst (705 687-3408)
Gravenhurst Shopping Centre
R.R. #1 P0C 1G0

Peterborough (705 743-2972)
139 George St. N. K9J 3G6

SOUTHEASTERN REGION

Kingston (613 549-4000)
133 Dalton Ave.,
P.O. Box 820
K7L 4X6

Cornwall (613 933-7402)
408 Pitt St., Box 1479
K6H 1B1

Belleville (613 962-9208)
15 Victoria Ave., K8N 1Z5

Ottawa (613 521-3450)
2378 Holly Lane K1V 7P1

Pembroke (613 732-3643)
Riverside Dr. K8A 6X1

NORTHEASTERN REGION

Sudbury (705 675-4501)
199 Larch St. P3E 5P9

North Bay (705 476-1001)
1500 Fisher St.
Northgate Shopping Centre
P1B 2H3

Sault Ste. Marie (705 949-4640)
445 Albert St. E. P6A 2J9

Parry Sound (705 746-2139)
74 Church St. P2A 1Z1

Timmins (705 264-9474)
83 Algonquin Blvd. W.
P4N 2R4

NORTHWESTERN REGION

Thunder Bay (807 475-1205/1315)
435 James St. S. P7C 5G6

Kenora (870 468-5578)
808 Robertson St. P9N 1X9

NOTES

FACTORS FOR CONVERSION OF METRIC UNITS TO IMPERIAL UNITS

Metric Units	Approximate Conversion Factor	Imperial Units
Linear		
centimetre (cm)	x 0.39	inch
metre (m)	x 1.1	yard
kilometre (m)	x 0.62	mile
Area		
hectare (ha)	x 2.5	acre
Volume		
cubic metre (m^3)	x 1.3	cubic yard
litre (l)	x 0.22	gallon
Weight		
Kilogram (kg)	x 2.2	pound
Applications of Units		
cubic metres per hectare (m^3/ha)	x 89	gallons per acre
kilograms per hectare (kg/ha)	x 0.89	pounds per acre